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**Human Factors Investigation
Into the Efficacy of Using the TCCCS AVH(ANR)
Headset with the Soldier's Helmet**

by

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Executive Summary

The Canadian Forces (CF) will be procuring a new Combat Vehicle Crewman (CVC) Helmet to replace the current DH 169A CVC helmet. This new helmet will overcome the limitations of the current helmet as well as provide ballistic protection, enhanced communications and suitable hearing protection while meeting the needs of all potential users for their tasks inside and outside combat vehicles. Preliminary investigations have identified the new Soldier's Helmet and the Tactical Command, Control and Communications (TCCCS) Armoured Vehicle Headset (AVH) headset as a potential option for a number of the Land Force's tracked M113 vehicles. The TCCCS AVH headset possesses active noise reduction (ANR). This investigation examined the suitability of the Soldiers Helmet and TCCCS AVH (ANR) headsets for use with M113 tracked vehicles.

A two-day dedicated trial was undertaken at CTC Gagetown over the period of 30 September to 01 October 1997. Four dedicated M113 vehicles and crews undertook a battery of human factors tests while wearing two CVC helmet conditions in a repeated measures design: the Soldier's Helmet with the AVH (ANR) and the in-service DH 169A. A second three-day field trial was undertaken at CFB Shiloh, over the period of 24-27 April 1998. While participating in combat team mechanized training, two mechanized infantry platoons in M113 tracked vehicles undertook a battery of human factors tests while wearing two CVC helmet/head conditions in a repeated measures design: the Soldier's Helmet with the AVH (ANR) and the AVH (ANR) with soft cap. Human Factors tests included assessments of fit, and adjustability, ease of use, comfort, clothing and equipment compatibility, communications performance, and task performance. Data collection included questionnaires, focus groups, performance measures and human factors observer assessments.

The specific aim of this study was to evaluate the Soldier's Helmet as a dedicated CVC helmet with the M113 tracked vehicle in a mechanized infantry setting and to specifically address the following issues:

- Determine the compatibility of the TCCCS AVH(ANR) headset when used with the Soldier's Helmet.
- Determine the performance and acceptability of the TCCCS AVH(ANR) and the Soldier's Helmet as a dedicated CVC helmet system.
- Based on the results of this trial propose changes to the human factors-related functional performance specifications.

The Soldier's Helmet and AVH(ANR) system was found to be: uncomfortable during prolonged use, heavy, incompatible with wind, sand, dust goggles and awkward to use as a system. Acceptability ratings for its ease of use as a system, compatibility with goggles, pressure point discomfort, neck discomfort and suitability for driving on rough ground were significantly lower from those obtained for the in-service DH-169a CVC helmet.

While the Soldier's Helmet and AVH(ANR) headset combination was superior to the significantly deficient in-service DH 169A in a number of areas, it was not the preferred solution for providing CVC helmet systems to M113 tracked vehicles. The subjects rated the Soldier's helmet and



AVH(ANR) headset system as being "Barely to Reasonably Unacceptable" for use with M113 tracked vehicles or for use in mechanized infantry operations. When asked outright which concept they would select, 25 out of the 26 trial subjects (96%) chose a new dedicated CVC over the hybrid Soldier's Helmet and AVH(ANR) system. The subjects envisioned a new CVC helmet that would overcome the limitations of the DH 169 and would be compatible with the new TCCCS vehicle mounted radio systems.

Based on the results of this investigation proposed changes to the human factors-related functional performance specifications are presented.



References:

- A Development of Human Factors Specifications for a New Combat Vehicle Crewman Helmet, Humansystems Incorporated report dated 15 July 1996
- B Human Factors Assessment of the Suitability of the New Soldier's Helmet for Use in Wheeled Armoured Vehicles, Humansystems Incorporated report dated 9 June 1997.
- C Human Factors Trial of the New Soldier's Helmet, Humansystems Incorporated report dated 29 November 1996.
- D DCIEM Land Forces Anthropometric Survey 1997 (In-press)

1. Background

The Canadian Forces (CF) will be procuring a new Combat Vehicle Crewman (CVC) Helmet to replace the current in-service CVC Helmet (Gentex DH 169A helmet). This new helmet will improve on the current helmet by providing increased thermal and physical comfort, enhanced communications and hearing protection, while meeting all user requirements for tasks performed inside and outside the combat vehicle. The DH 169A is compatible with the VRC 77 radio system but is not compatible with the TCCCS family of radios and headsets, which are replacing the VRC 77 systems.

As part of the Clothe the Soldier initiative, DCIEM has been tasked to provide Human Factors (HF) support to the development of a new combat vehicle crewman (CVC) helmet design which overcomes the shortcomings identified with the in-service DH 169A. The new CVC helmet must be compatible with the TCCCS family of communication headsets. To date, DCIEM has conducted human factors investigations with commercial-off-the-shelf (COTS) CVC helmet systems (Reference A) and has investigated the feasibility of using the Soldier's Helmet as a CVC helmet for the bulk of the CF wheeled family of vehicles using the Slimgard II headset (Reference B). Overall the Soldier's helmet and TCCCS Slimgard II system was rated as reasonably acceptable for use in wheeled vehicles and participants viewed the single helmet concept of operations as highly desirable. Participants preferred the Soldier's Helmet/Slimgard II CVC helmet system to the in-service DH 169A helmet system.

The degree to which the Soldier's Helmet and TCCCS AVH (ANR) can act as a CVC helmet for tracked vehicles (M113 family) was unknown. The TCCCS AVH (ANR) headset is significantly larger than the previously trialled Slimgard II headset and the larger profile may cause clash, thus breaking the seal of the ANR headsets. Failure to maintain a proper seal with ANR headsets will counter-act their noise protection capabilities and may even amplify harmful noise. Seal leakage may not be readily evident during static compatibility tests (Reference B and C) or evaluations on a set driver's course (Reference A), rather evaluation of the helmet/ANR seal should be conducted



in a tactical field setting. The Clothe the Soldier project team requested that DCIEM investigate these issues through a controlled HF field trial.

2. Aim

The primary aim of this field trial is to evaluate the human factors (HF) suitability of Soldier's Helmet and AVH (ANR) in an over the helmet configuration as a CVC helmet for tracked vehicles (M113 family).

3. Method

3.1 Overview

The following description provides a general overview of the trial method. Further details are provided in subsequent sections.

3.1.1 CFB Gagetown Trial

A two-day dedicated trial was undertaken at the Combat Training Center (CTC) in CFB Gagetown over the period of 30 September to 01 October 1997. Four dedicated M113 vehicles and crews undertook a battery of human factors tests while wearing two CVC helmet conditions in a repeated measures design: the Soldier's Helmet with the AVH (ANR) and the in-service DH 169A. During the evaluation, the order of CVC helmet conditions was balanced among participants. Human factors tests will included assessments of fit, adjustability, accessibility, performance of basic mounted troop/ platoon manoeuvre drills, held-up drills, and vehicle compatibility. Data collection included questionnaires, focus groups, performance measures and HF observer assessments.

The approach was to conduct troop/platoon advance to contact traces the length of the Lawfield Corridor. Using proper driving drills the participants moved tactically using leapfrog and caterpillar movement. At each bound the vehicle commanders alternated in giving the SITREP to the other vehicles indicating the best route, possible positions on the next bound and how far they can support.

3.1.2 CFB Shiloh Trial

A three-day trial was undertaken at CFB Shiloh over the period of 24-27 April 1998. A series of mechanized infantry platoons in M113 tracked vehicles participating in combat team training undertook a battery of human factors tests while wearing two CVC helmet/head conditions in a repeated measures design: the Soldier's Helmet with the AVH (ANR) and the AVH(ANR) and soft cap. During the evaluation, the order of CVC helmet/head conditions was balanced among participants. Human factors tests included assessments of fit, adjustability, accessibility, ease of use, performance of basic mounted platoon manoeuvre and dismount drills, communications



assessment, held-up drills, and equipment and vehicle compatibility. Data collection included questionnaires, focus groups, performance measures and HF observer assessments.

The approach was to evaluate the helmet/head conditions while the mechanized infantry platoons participated in combat team exercises on the Berlin Battle Run. As per the exercise scenario, the participants moved tactically using platoon formations. Additionally, each platoon conducted rapid dismount and marrying-up drills with Leopard tanks.

3.2 Trial Participants

Twenty-six (26) male regular force infantry soldiers participated from CFB Gagetown and Winnipeg. The participants selected for the CFB Gagetown trial were organized into a command element (Company 2/IC) and a mechanized platoon (+), while the participants selected for the CFB Shiloh trial were organized into two mechanized infantry platoons each with four M113 vehicles. A HF observer was assigned to work with each platoon for the purposes of data collection and focus group discussions.

3.2.1 MOC

Participants were selected from the 031 Infantry MOC.

3.3 CVC Helmet Conditions

The following three CVC helmet/head systems will be evaluated in the trial.

3.3.1 Combat Vehicle Crewman Helmet Model DH 169A

The in-service DH 169A CVC helmet is a two piece helmet that provides noise attenuation, impact and ballistic protection, and external communications. The DH 169A is compatible with the AN/VRC-77 radio system currently employed in Land Force armoured vehicles. The helmet system consists of six major components: outer ballistic shell and bump protective shield, inner liner with energy absorbing foam, communication headset and microphone assembly, chest switch assembly and an outside "talk-through" communication system. The "talk-through" system consists of a module and switch mounted on the left ear piece and an externally replaceable battery system mounted in the right ear piece. The DH 169A is provided with three differently sized inner liners (small, medium, and large) and two sizes of outer ballistic shells (small/medium and medium/large). The complete system with drop cord weighs 1.65 kg. See Figures 1 and 2.



Figure 1: Gentex DH-169 CVC Helmet (Front View)



Figure 2: Gentex DH-169 CVC Helmet (Side View)



3.3.2 Soldier's Helmet/ TCCCS AVH(ANR) Communication System

The Soldier's Helmet is a one-piece helmet shell that provides a high degree of ballistic protection (i.e. $V50 > 610\text{m/sec}$) and a trauma liner for bump protection.. The helmet's suspension system is comprised of a crown pad and an adjustable headband while the retention system is comprised of a three-point chin/nape strap with four adjustment straps. The Soldier's Helmet is available in three sizes and weighs 1.5 kg (Medium). See Figure 3. Three helmets were modified with extended nape straps (2.54 centimeters) to determine if the modification could improve headset compatibility.

The AVH (ANR) headset provides enhanced active noise reduction (ANR) hearing protection and connectivity to combat vehicle radio/intercom systems. The AVH (ANR) system includes a manual valve that enables "talk-through" in quiet conditions when "open", but provides hearing protection for impulsive or high ambient noise when "closed". The AVH (ANR) headset has two noise attenuating earshells, molded in high impact ABS and is secured to an adjustable spring neckband. There are sensing microphones on each ear shell and electronic circuitry for ANR function. The AVH (ANR) headset, including a one meter coiled drop cord and Velcro head strap, weighs 0.99 kg.

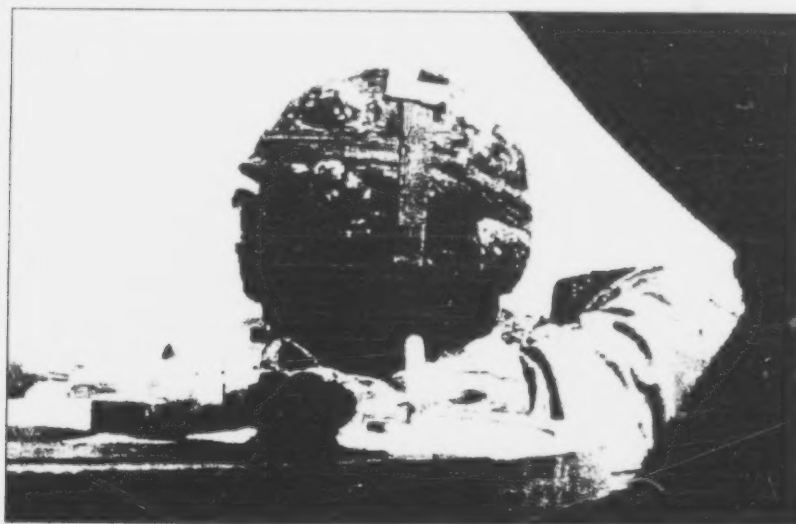


Figure 3: Soldier's Helmet with AVH(ANR) Headset



3.3.3 Soft Cap/ TCCCS AVH(ANR) Communication System

As mentioned earlier, the current in-service CVC helmet (DH 169A) is deficient in communications reliability, ballistic protection, comfort, sound attenuation and is not compatible for all equipment and sighting systems currently in use on armoured fighting vehicles. Due to the planned replacement of the DH 169A, there is also a critical shortage of DH 169A helmets and spare parts in the CF inventory consequently, the CVC helmet is not worn by many armoured vehicle crews. In order to maintain communications between and within vehicles many units utilize communication headsets worn over soft caps – see Figure 4.

The AVH (ANR) headset provides enhanced active noise reduction (ANR) hearing protection and connectivity to combat vehicle radio/intercom systems. The AVH (ANR) system includes a manual valve that enables “talk-through” in quiet conditions when “open”, but provides hearing protection for impulsive or high ambient noise when “closed”. The AVH (ANR) headset has two noise attenuating earshells, molded in high impact ABS and is secured to an adjustable spring neckband. There are sensing microphones on each ear shell and electronic circuitry for ANR function. The AVH (ANR) headset, including a one meter coiled drop cord and plastic head strap, weighs 0.98 kg.



Figure 4: Soft Cap with TCCCS AVH(ANR)



3.3.4 Helmet/Head Conditions

The participant sample was split into two groups. The first group included the 10 participants who assessed the Soldier's Helmet w/ANR and the DH 169A CVC Helmet, and the second group, which assessed the Soldier's Helmet w/ANR and just the ANR headset over a soft cap.

	CFB Gagetown (n=10)	CFB Shiloh (n=16)
Helmet Types	SH and ANR DH 169	SH and ANR Soft cap and ANR

Table 1: Helmet/head Conditions

The Soldier's Helmet and ANR system was evaluated by both participant groups (n=26). The order in which the participants wore the CVC helmet conditions was balanced.

3.4 Data

Data collection focussed on the following HF criteria. Test content is described in more detail below. The order in which trial participants will trial Fighting Order conditions will be balanced.

1. Anthropometry
2. Fit/Adjustability
3. Physical Comfort
4. Thermal Load
5. Ease of Movement
6. Vehicle Compatibility
7. Vehicle Drill Performance
8. Acceptance

Participants rated the acceptability of various items on the following seven-point scale (Figure 5).

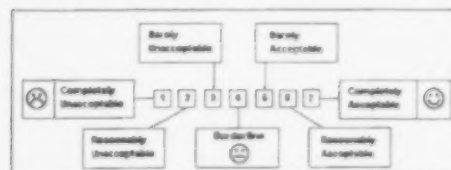


Figure 5: Rating Scale for Acceptability

3.4.1 Anthropometry

Each participant was measured for head circumference, head length, and head breadth.



3.4.2 Fit and Adjustment

Following assembly instructions, participants were required to adjust the Soldier's Helmet and AVH (ANR) sizing and perform donning/doffing trials. Upon completion of adjustment and fitting, participants completed a Fitting Questionnaire. HF observers evaluated the ease of fitting and the acceptability of the final fit.

3.4.3 First Impressions

At the beginning of the trial, participants were required to rate the appearance, durability and protection offered by the Soldier's Helmet and TCCCS AVH (ANR) CVC helmet system.

3.4.4 Ease of Head Movements

Participants were required to rate the ease of head movements for the CVC helmet systems. These included:

- a. entering and exiting hatches;
- b. looking through vision blocks;
- c. looking at gauges; and
- d. hatches-up driving.

3.4.5 Physical Comfort

Participants were required to rate their physical comfort associated with each CVC helmet system. Physical comfort was assessed as follows:

- a. pressure points;
- b. skin irritation;
- c. weight;
- d. hot spots; and
- e. neck discomfort.

3.4.6 Driving

Participants were required to rate the acceptability of the CVC helmet systems when driving over:

- a. hard packed roads;
- b. gravel roads; and
- c. rough ground.

3.4.7 Communication

Participants were required to rate the acceptability of the CVC helmet systems for communications as follows:



- a. donning and doffing;
- b. physical comfort;
- c. thermal comfort;
- d. ear seal;
- e. speech quality;
- f. ANR seal leakage;
- g. talk-through quality;
- h. vehicle noise;
- i. wind noise;
- j. microphone positioning;
- k. over-head Velcro strap acceptability; and
- i. overall communications rating.

3.4.8 User Acceptance of the Combined Helmet/Communication System

To assess user acceptance, participants were required to rate their overall acceptance of the CVC helmet systems, including their perceived level of protection, wearability, and the communications performance, using an exit questionnaire.

3.5 Trial Schedules

Tables 2 and 3 outlines the two-day trial CFB Gagetown schedule and the three day CFB Shiloh trial

CFB Gagetown Trial: -30 September to 01 October 1997		
Time	Day 1	Day 2
A.M.	Initial Briefing Anthropometry CVC helmet Issue Mount Modified 2298 Demonstration of ANR	Move to training area Begin advance to contact trace
A.M.	Move to south end of training area and begin trace (moving N)	Conduct advance to contact trace
Lunch	In the field	In the field
P.M.	Advance to contact trace	Advance to contact trace Exit focus group/questionnaires

Table 2: CFB Gagetown Trial Schedule



CFB Shiloh Trial: 24-27 April 1998				
Time	Day 1	Day 2	Day 3	Day 4
AM		Move to training area Participate in Combat Team Exercise	Move to training area Participate in Combat Team Exercise	Move to training area Participate in Combat Team Exercise
Lunch		In the field	In the field	In the field
P.M.		Participate in Combat Team Exercise Exit Focus Group/Debrief	Participate in Combat Team Exercise Exit Focus Group/Debrief	Participate in Combat Team Exercise Exit Focus Group/Debrief
Supper	TBD	In garrison	In garrison	In garrison
Night	Initial Briefing Anthropometry CVC helmet Issue Mount Modified 2298 Demonstration of ANR	Initial Briefing Anthropometry CVC helmet Issue Mount Modified 2298 Demonstration of ANR	Initial Briefing Anthropometry CVC helmet Issue Mount Modified 2298 Demonstration of ANR	

Table 3: CFB Shiloh Trial Schedule

The following two meetings bracketed the trial schedule:

Initial Briefing: Initially, participants were welcomed and introduced to the trial team. Participants were briefed on the trial schedule and data collection methods (i.e. questionnaires, focus groups, etc.). Questionnaire briefings explained the standard rating scale, the data scoring method and rules of questionnaire completion. The helmet/head and ANR systems were introduced and participants were provided with a demonstration of helmet and ANR assembly, adjustment, and features.

Exit/Debriefing visits: Following completion of the trial, participants were required to complete an exit questionnaire (Annex B). Exit focus groups were held following the completion of the exit questionnaires.



3.6 Statistical Analyses

A repeated Paired T-Test analysis was undertaken for the initial fit questionnaire acceptability rating results within groups. Meta-analysis was conducted between the trial groups for the exit questionnaire using an incomplete block approach. Missing data was replaced with mean data to prevent casewise deletion of data. Differences were identified at $p < 0.05$.



4. Results

Results are summarized below. Data from each trial has been combined. The data was analyzed using an independent t-test. Statistically significant differences are noted at $p < 0.05$.

4.1 Anthropometry

Anthropometric measurements of the participants were taken for head circumference, head breadth, and head length. The combined trial participants' measurements were compared to the 1997 DCIEM Anthropometric Survey (reference A). These anthropometric measurements are shown in Table 4 below.

Anthropometric Measurement	CVC Trial		1997 DCIEM Anthro. Study (Males)		
	Mean	S.D.	Mean	S.D.	
Head Circumference (cm)	56.8	1.6	57.6	1.5	
Head Breadth (cm)	15.2	0.5	15.3	0.6	
Head Length (cm)	19.8	0.6	19.9	0.7	

Table 4 Anthropometric Measurements

The results of the anthropometric analysis indicate that the trial participants were representative of the Land Force. There were no significant differences ($p < 0.05$) in head circumference, breadth or length.

The distribution of the trial participants is depicted below (•) in Figure 6 overlaid on the bivariate plot of head length by breadth for the DCIEM 1997 Land Force Anthropometric Survey.

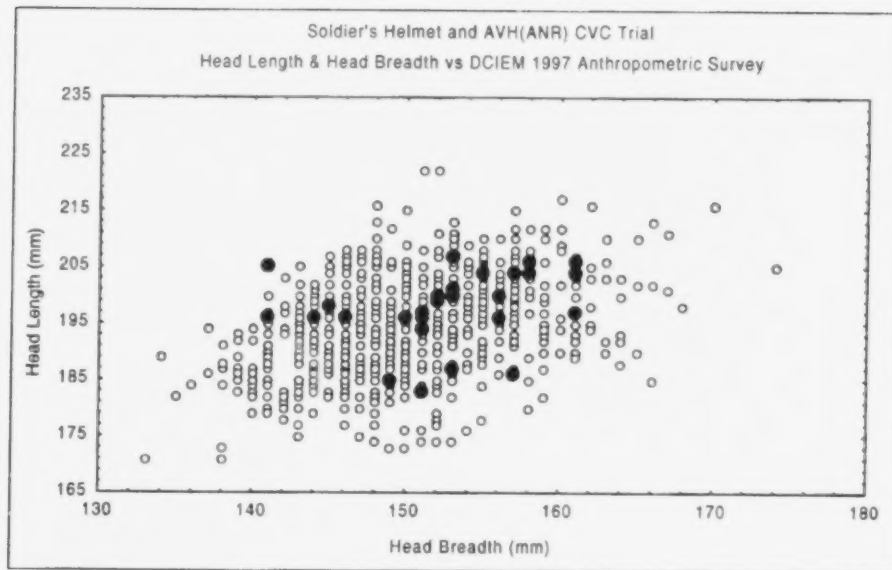


Figure 6: Plot of Trial Participants versus Land Force Males (Head Length versus Breadth)

4.2 Helmet Usage

A comparison of the total hours of use with the CVC helmet conditions for both trial groups are presented in Table 5.

Helmet	n	Mean	S.D.	Min.	Max
Soldiers Helmet and ANR (Gagetown)	10	2.9	1.0	1.0	2.9
Gentex DH-169A (Gagetown)	10	2.1	1.0	2.1	4.0
Soldiers Helmet and ANR (Shiloh)	16	3.9	1.2	2.0	5.0
Soft Cap and ANR (Shiloh)	16	3.6	1.3	2.5	5.5

Table 5: Helmet Usage Comparison Data (Total Hours)

There were significant differences in total time of Soldier's Helmet and AVH(ANR) usage between the CFB Gagetown and CFB Shiloh trials. Time on task for the CFB Gagetown trial was reduced because of vehicle breakdowns.



4.3 First impressions/ Fit and Adjustment

The first impressions and fit and adjustment questionnaire results are summarized below in Table 6.

Features	Soldier's Helmet and ANR (Shiloh)		Soldier's Helmet and ANR (Gagetown)	
	Mean	S.D.	Mean	S.D.
Ease of Assembly	5.6	1.1	5.2	1.2
Chin Strap Adjustment	5.4	1.0	5.0	1.2
Harness Adjustment	5.1	0.9	5.6	1.4
Initial Fit	5.4	1.2	5.4	1.3
Ease of Donning	4.7	1.2	4.8	1.8
Ease of Doffing	5.2	1.2	5.1	1.8
First Impressions				
Appearance	4.9	1.5	5.5	1.7
Durability	4.8	1.4	4.5	2.0
Protection	5.4	1.0	5.6	0.7

Table 6: Fit and Adjustment Questionnaire Results

4.3.1. Features

Ease of Assembly: Ease of assembly of the Soldier's Helmet and ANR CVC system was rated as "Barely to Reasonably Acceptable" for both trial groups. Participants noted that the CVC system was fairly easy to assemble.

Chin Strap Adjustment: The ease of chin strap adjustment was rated as "Barely to Reasonably Acceptable" for both trial groups. The soldier's helmet requires up to four adjustments for the chin/nape strap. The chin strap did not interfere with the AVH (ANR) headset.

Harness Adjustment: Harness adjustment was similarly rated for both helmet trial groups as "Barely to Reasonably Acceptable". Participants noted that while there are a number of adjustments required for the soldier's helmet, they are easy to perform.



Initial Fit: Initial fit was rated as "Barely to Reasonably Acceptable" for both trial groups.

Ease of Donning: Ease of Donning the helmet and AVH(ANR) headset CVC system was rated as "Borderline to Barely Acceptable" for both trial groups. Donning the headset properly to ensure an adequate ear cup seal as well as to properly attach the Velcro helmet bands required finesse.

Ease of Doffing: Doffing the helmet was rated by both trial groups as being "Barely to Reasonably Acceptable". Doffing the headset and then the helmet was relatively simple.

4.3.2. First Impressions

Appearance: The appearance of the new Soldiers Helmet and AVH(ANR) CVC helmet system was rated as being between "Borderline to Reasonably Acceptable" for the two trial groups. While the CFB Gagetown group rated the appearance of the Soldiers Helmet and AVH(ANR) CVC helmet system as being "Reasonably Acceptable" (5.5), the CFB Shiloh group rated the appearance as being "Barely Acceptable" (4.9). While the differences between the groups was not statistically significant, the differences may be attributed to the fact that this was the first time that the CFB Gagetown personnel had worn the new helmet.

Durability: The durability of the new Soldiers Helmet and AVH(ANR) CVC helmet system was rated as being between "Borderline to Barely Acceptable" for the two trial groups. The lower durability ratings were attributed to the independent headsets and the use of Velcro in the attachment system. Some participants had grave concerns whether the headsets could stand-up to the punishment expected inside an armoured vehicle. Other participants noted that the Velcro straps would wear out relatively quickly and would not work when wet or covered with snow and ice in the winter.

Protection: The level of protection afforded by the new Soldiers Helmet and AVH(ANR) CVC system was rated as being "Barely to Reasonably Acceptable" by both trial groups. The "Reasonably Acceptable" ratings for the new Soldiers Helmet and AVH(ANR) CVC system were primarily attributed to its ballistic and bump protection.

4.4 Exit Questionnaire

Results from the trial exit questionnaire are summarized below by functional criteria: helmet alone, communications equipment alone and helmet and communications equipment combined and concept of operations.

4.4.1. Helmet Alone

Helmet alone results are displayed in Figure 7 and detailed in Table 7 (below).

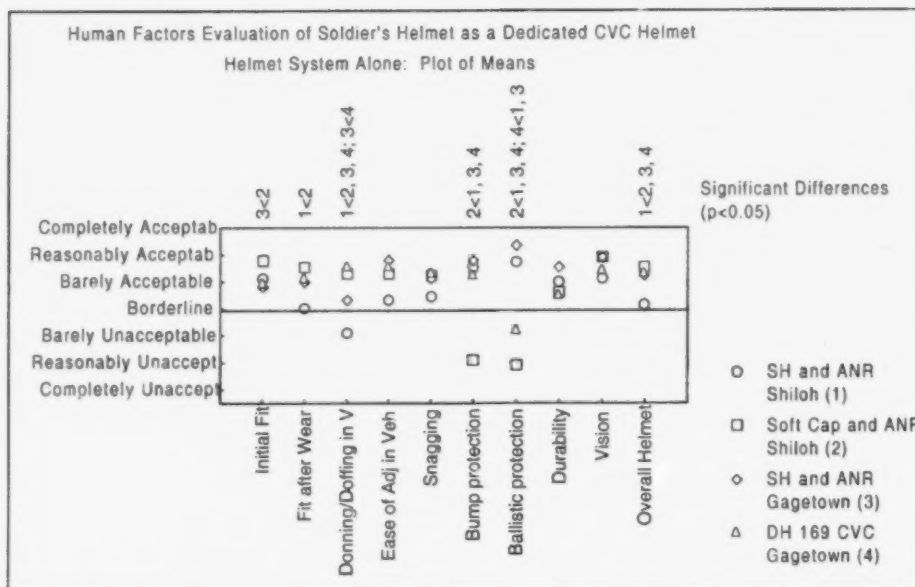


Figure 7: Exit Questionnaire Results (Helmet Alone)

Features	Soldier's Helmet and ANR (Shiloh)		Soft Cap and ANR (Shiloh)		Soldier's Helmet and ANR (Gagetown)		DH-169A CVC (Gagetown)	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Initial Fit	5.1	0.3	5.8	0.2	4.8	0.5	4.9	0.6
Fit After Wear	4.0	0.5	5.5	0.3	5.0	0.5	5.1	0.5
Donning/Doffing in Vehicle	3.1	0.4	5.3	0.3	4.3	0.5	5.5	0.5
Ease of Adjustment in Vehicle	4.3	0.4	5.3	0.3	5.8	0.5	5.5	0.5
Snagging	4.4	0.3	5.2	0.3	5.1	0.4	5.3	0.4
Bump Protection	5.5	0.3	2.1	0.4	5.8	0.4	5.2	0.4
Ballistic Protection	5.7	0.3	1.9	0.4	6.3	0.3	3.2	0.4



	Soldier's Helmet and ANR (Shiloh)		Soft Cap and ANR (Shiloh)		Soldier's Helmet and ANR (Gagetown)		DH-169A CVC (Gagetown)	
Features (Cont.)	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Durability	5.0	0.2	4.6	0.3	5.5	0.5	4.5	0.4
Vision	5.1	0.3	5.9	0.3	5.9	0.3	5.4	0.5
Overall Helmet	4.1	0.4	5.5	0.3	5.2	0.3	5.3	0.4

Table 7: Exit Questionnaire Results (Helmet Alone)

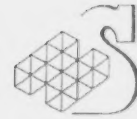
4.4.1.1. Features

The new soldiers helmet AVH(ANR) combination was rated significantly different from the Soft Cap and In-service DH 169 CVC helmet in a number of criteria. Except for Donning/Doffing and Overall Acceptability, there were no differences in the ratings of the helmet component alone between the two trials. Ratings for these features ranged from "barely to reasonably acceptable".

Initial Fit: The initial fit for all the helmet/head conditions were rated as being "Barely to Reasonably Acceptable". The initial fit of the soft cap was rated as being significantly ($p < 0.05$) more acceptable than the initial fit of the Soldier's helmet in the CFB Gagetown trial. There was no significant difference in the initial fit of the Soldier's Helmets with a modified nape strap.

Fit After Wear: The fit after wear for all the helmet/head conditions was rated as being "Borderline to Reasonably Acceptable". The fit after wear of the soft cap was rated as being significantly ($p < 0.05$) more acceptable than the fit after wear of the Soldier's helmet in the CFB Shiloh trial. The subjects found that once they were sweating, the soldiers helmet tended to slip lower on the head causing the ANR ear cups to rest uncomfortably on the top of the ears. This phenomenon was possibly not apparent at CFB Gagetown due to the relatively cool trial conditions..

Donning/Doffing in Vehicle: The ease of donning and doffing the helmet/head cover was rated as being acceptable "Borderline to Barely Acceptable" for the Soft cap, DH 169A CVC and Soldier's Helmet -CFB Gagetown conditions. The ease of donning and doffing the helmet/head cover was rated as being unacceptable "Barely Unacceptable to Borderline" for the Soldier's Helmet -CFB Shiloh condition. The rating of the Soldier's Helmet -CFB Shiloh was significantly ($p < 0.05$) less acceptable than the Soft cap, the Soldier's Helmet -CFB Gagetown, and the DH 169A conditions. . The Soldier's Helmet -CFB Gagetown ease of donning/doffing was rated significantly ($p < 0.05$) less acceptable than the DH 169A condition. Participants found donning the Soldier's



Helmet and ANR to be more time consuming and problematic than the dedicated DH 169A CVC or the soft cap.

Ease of Adjustment in Vehicle: The ease of adjustment in vehicle for all the helmet/head conditions was rated as being "Borderline to Reasonably Acceptable". Participants found that it was relatively easy to adjust their helmets while in their crew stations.

Snagging: The acceptability for snagging for all the helmet/head conditions was rated as being "Borderline to Barely Acceptable". Participants noted that the profile of the new Soldiers Helmet, did not present a snagging hazard.

Bump Protection: The subjects rated the acceptability for bump protection for the Soft cap condition as being "Reasonably Unacceptable" conversely, the acceptability for bump protection of the other helmet conditions was rated as being "Barely to Reasonably Acceptable". The perceived bump protection that was offered by the soft cap was significantly less acceptable ($p < 0.05$) than the protection offered by Soldier's Helmet conditions or the DH 169A helmet. Participants noted that the soft cap offered no serious bump protection. The new Soldiers Helmet was perceived to provide even more bump protection than the DH 169A CVC helmet.

Ballistic Protection: The subjects rated the acceptability for ballistic protection for the Soft cap and DH 169 conditions as being "Barely to Reasonably Unacceptable" conversely, the acceptability for ballistic protection of the Soldier's Helmet conditions was rated as being "Barely to Reasonably Acceptable". The perceived ballistic protection offered by the soft cap and DH 169 was significantly less acceptable ($p < 0.05$) than the protection offered by Soldier's Helmet. The perceived ballistic protection that was offered by the DH 169A was significantly more acceptable ($p < 0.05$) than the protection offered by the Soft cap.

Durability: The acceptability for all the helmet/head conditions for durability was rated as being "Borderline to Barely Acceptable". There were no significant differences between helmet conditions. Participants noted however, that the Soldier's Helmet with ANR had not received enough time on task to adequately assess its durability. The DH 169A CVC helmet received borderline ratings due primarily to some of the participants' experience with the helmet in Bosnia where the helmet was not found to be very durable.

Vision: The acceptability for vision for all the helmet/head conditions was rated as being "Barely to Reasonably Acceptable". There were no significant differences between helmet conditions and none of the conditions interfered with commander's or driver's vision.



4.4.1.2. Overall Ratings (Helmet Only)

Overall the new Soldiers Helmet with AVH(ANR)-Shiloh (4.1) was rated significantly lower than the acceptability of the DH 169 CVC helmet (5.3), Soft cap and AVH(ANR) (5.5) and Soldier's helmet and AVH(ANR)-Gagetown (5.2.) As a dedicated CVC helmet, the Shiloh subjects found this helmet more difficult to use for donning/doffing and adjusting in the vehicle. The Shiloh subjects also disliked the fact that sweating caused the helmet and thus the headset to slide down on the head pushing pressure on the ears.

4.4.2. Communications Equipment

Results from the exit questionnaire dealing specifically with Communications equipment are displayed in Figure 8 and detailed in Table 8 (below).

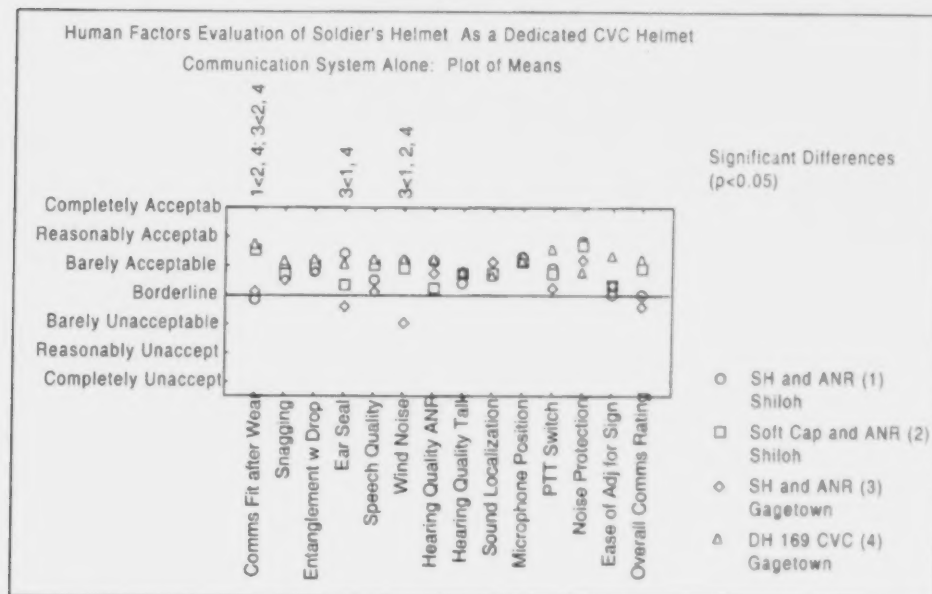


Figure 8: Exit Questionnaire Results (Communications Equipment)



	Soldier's Helmet and ANR (Shiloh)		Soft Cap and ANR (Shiloh)		Soldier's Helmet and ANR (Gagetown)		Gentex DH- 169 CVC (Gagetown)	
Features	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Fit after Wear	3.8	0.4	5.5	0.2	4.1	0.4	5.7	0.4
Snagging	4.9	0.3	4.7	0.4	4.5	0.4	5.1	0.4
Entanglement with Drop Cord	4.8	0.3	5.0	0.4	4.8	0.5	5.2	0.3
Ear Seal	5.4	0.3	4.3	0.5	3.6	0.5	5.0	0.5
Speech Quality	4.5	0.5	5.0	0.4	4.1	0.5	5.2	0.4
Wind Noise	5.1	0.4	4.9	0.5	3.0	0.6	5.2	0.3
Hearing quality (ANR)	5.1	0.4	4.2	0.5	4.7	0.5	5.2	0.3
Hearing quality (Talk Through)	4.4	0.5	4.7	0.4	4.8	0.6	4.7	0.4
Sound Localization	4.7	0.4	4.7	0.4	5.1	0.3	4.6	0.3
Microphone Positioning	5.3	0.4	5.1	0.5	5.3	0.5	5.1	0.2
PTT Switch	4.9	0.4	4.7	0.4	4.2	0.6	5.5	0.4
Noise Protection	5.8	0.3	5.7	0.3	5.2	0.4	4.7	0.3
Ease of Adjustment to Minimize Comms Distortion and Signal Loss	4.0	0.4	4.3	0.4	4.3	0.5	5.3	0.5
Comms Only								
Overall Rating	4.0	0.5	4.9	0.4	3.6	0.4	5.2	0.3

Table 8: Exit Questionnaire Results (Communications Equipment)



4.4.2.1. Features

Fit After wear: The subjects rated the acceptability for the communications fit after wear for the Soft cap and DH 169A conditions as being "Barely to Reasonably Acceptable". Conversely, the acceptability communications fit after wear of the soldier's helmet conditions was rated as being "Barely Unacceptable to Borderline". The Soft cap and DH 169A CVC communication conditions were rated as being significantly ($p < 0.05$) more acceptable than both Soldier's Helmet conditions. Many users found that the top of the AVH(ANR) ear cups were being forced into the side of their heads. Universally, the subjects wished for a slimmer profile AVH(ANR) headset. There was no significant differences in the acceptability of headset fit after wear for the users with the Soldier's Helmets with modified nape straps.

Snagging: The subjects rated the acceptability against snagging for all helmet/head conditions as being "Borderline to Barely Acceptable". A number of drivers commented that the drop cord with the AVH(ANR) headset was on the wrong side for the current positioning of their 2298 boxes. The cord got snagged on their seats.

Entanglement with Drop Cord: The subjects rated the acceptability against entanglement with drop cord for all helmet/head conditions as being "Barely Acceptable".

Ear Seal: The ear seal with the Shiloh Soldier's Helmet AVH(ANR) (5.4) and the DH 169 CVC (5.0) was rated significantly ($p < 0.05$) higher than the acceptability of the ears seal with the Gagetown Soldier's helmet and AVH(ANR) (3.6). Participants noted that the over-the-helmet Velcro straps when properly positioned, aided in attaining a good ear seal. The Gagetown participants believed that the dedicated DH 169A provided a better seal than the AVH (ANR) headsets. FB Gagetown subjects found that helmet straps, goggle straps, and prescription glasses or sunglasses broke the ear cup seals on the AVH (ANR).

Speech Quality: The subjects rated the acceptability for speech quality for all the helmet/head conditions as being "Borderline to Barely Acceptable".

Wind Noise: The Gagetown Soldier's Helmet AVH(ANR) system was rated as being "Barely Unacceptable" for wind noise, significantly ($p < 0.05$) less acceptable than the other three helmet/head conditions. The Shiloh Soldier's helmet AVH(ANR), Soft cap and DH 169 CVC helmets were rated as being "Barely Acceptable" for wind noise. The fact that the Shiloh subjects were primarily in a "listening" mode or communicated during short halts, and the Gagetown participants were sending messages on the move may account for the differences in the wind noise acceptability ratings. It is notable that the Gagetown participants rated the AVH(ANR) significantly less acceptable than the DH 169A communication system for wind noise.



Hearing Quality (ANR): The subjects rated the acceptability for hearing quality (ANR for the AVH and electronic for the DH 169A) for all the helmet/head conditions as being "Borderline to Barely Acceptable"...

Hearing Quality (Talk-Through): The subjects rated the acceptability for talk-through hearing quality for all the helmet/head conditions as being "Borderline to Barely Acceptable". Participants thought the talk-through capability on the AVH(ANR) headsets was excellent. Many subjects were unaware of the talk-through capability of the DH 169A.

Sound Localization: The subjects rated the acceptability for sound localization for all the helmet/head conditions as being "Borderline to Barely Acceptable". The AVH(ANR) communication headsets did not cause any additional problems for detecting sound sources.

Microphone Positioning: The subjects rated the microphone positioning acceptability for all the helmet/head conditions as being "Barely Acceptable". Some participants found the AVH(ANR) boom microphone were too short, but the pivot arm was superior. Participants liked the ease of moving the AVH(ANR) microphone away from the mouth without having to reposition it after having had a drink or a cigarette. Participants noted that the DH 169A microphone did not hold its position well and that the electrical attachment from the microphone to the support arm was not robust and released too easily.

PTT Switch: The subjects rated the acceptability of the push-to-talk (PTT) switch for all the helmet/head conditions as being "Barely Acceptable". A number of subjects expressed the desire to increase the distance between the AVH(ANR) PTT Switch and headset by 15 centimeters.

Noise Protection: The subjects rated the acceptability of noise protection provided by the communication headsets as being "Borderline to Barely Acceptable" for all helmet/head conditions. Generally, the AVH(ANR) headsets provided better noise protection than the DH 169A.

It is notable that there was no significant difference in the level of noise protection provided between the Soldier's Helmet with AVH(ANR) and the soft cap and AVH(ANR). Wearing the AVH(ANR) over the soft cap frequently causes the seal to break and thus should adversely affect the noise protection provided. None of the CFB Shiloh participants noted any feedback or "oil canning" when wearing the AVH(ANR) over the soft cap.

Ease of Adjustment to Minimize Communications Distortion: The subjects rated the ease of adjusting the communication system to minimize communication distortion as being "Borderline to Barely Acceptable" for all helmet/head conditions. Generally, the DH 169A was easier to adjust than the AVH(ANR) headset. The system of using modified 2298 boxes and VRC 77 sets with the AVH(ANR) may have caused signal adjustment difficulties.



4.4.2.2. Overall Rating

The overall communication system acceptability rating for the Gagetown-Soldier's Helmet AVH(ANR) (3.6) was lower than the acceptability rating for the Shiloh-Soldier's Helmet AVH(ANR) (4.0), Soft cap (4.9) and DH 169A CVC (5.2). While the overall communications system acceptability for the Soldier's Helmet AVH(ANR) systems were lower than the Soft cap or DH 169A, the differences were not significant.

4.4.3. Combined Helmet and Communications Equipment

Combined helmet and communications equipment results from the exit questionnaire are displayed in Figure 9 and detailed in Table 9.

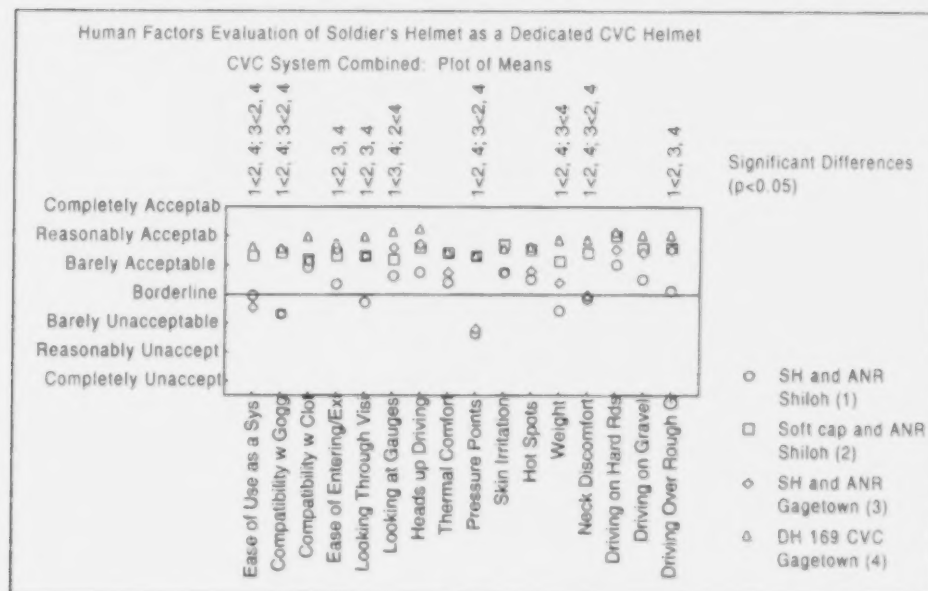


Figure 9: Exit Questionnaire Results (Combined CVC System)



Features	Soldier's Helmet and ANR (Shiloh)		Soft Cap and ANR (Shiloh)		Soldier's Helmet and ANR (Gagetown)		Gentex DH- 169 CVC (Gagetown)	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Ease of Use as a System	3.9	0.5	5.3	0.4	3.5	0.5	5.6	0.4
Compatibility between helmet and ANR								
Compatibility with Goggles	3.3	0.5	5.4	0.4	3.3	0.4	5.5	0.5
Clothing Compatibility	4.9	0.4	5.2	0.3	5.1	0.3	5.9	0.3
Ease of Head Movements								
Entering/Exiting Hatches	4.3	0.5	5.3	0.4	5.5	0.2	5.7	0.3
Looking through Vision Blocks	3.7	0.5	5.3	0.3	5.3	0.3	5.9	0.3
Looking at Gauges	4.6	0.4	5.2	0.3	5.6	0.3	6.1	0.3
Hatches-Up Driving	4.7	0.5	5.6	0.3	5.7	0.3	6.2	0.3
Thermal Comfort	4.4	0.4	5.4	0.3	4.7	0.4	5.4	0.5
Physical Comfort								
Pressure Points	2.6	0.5	5.3	0.4	2.8	0.4	5.3	0.5
Skin Irritation	4.7	0.5	5.7	0.3	4.7	0.5	5.5	0.5
Hot Spots	4.5	0.5	5.5	0.3	4.8	0.6	5.6	0.5
Weight	3.4	0.5	5.1	0.4	4.4	0.6	5.8	0.4
Neck Discomfort	3.8	0.5	5.4	0.4	3.9	0.7	5.8	0.4
Driving								
Hard Surface	5.0	0.7	6.0	0.2	5.5	0.3	6.1	0.4
Gravel Surface	4.5	0.6	5.6	0.3	5.4	0.3	6.0	0.3
Rough Ground	4.1	0.5	5.6	0.3	5.5	0.3	6.0	0.3

Table 9: Exit Questionnaire Results (Combined Helmet and Comms)



4.4.3.1. Features

Ease of Use as a System: The Soldiers Helmet AVH(ANR) systems were rated as being "Barely Unacceptable to Borderline" for ease of use. The Soft cap and DH 169A were rated as "Barely to Reasonably Acceptable" for ease of use as a system. The Soldier's Helmet AVH(ANR) conditions were significantly ($p < 0.05$) less acceptable than the Soft cap or DH 169A for ease of use. Many subjects found it difficult to don the system achieving an adequate seal. Many participants had to adjust their helmets to achieve minimal compatibility. The participants found that the helmet straps were problematic and slipped off too easily.

Compatibility with Goggles: The Soldiers Helmet AVH(ANR) systems were rated as "Barely Unacceptable to Borderline" for compatibility with Sand, Wind and Dust Goggles. The Soft cap and DH 169A were rated as "Barely to Reasonably Acceptable" for compatibility with goggles. The Soldier's Helmet AVH(ANR) conditions were significantly ($p < 0.05$) less acceptable than the Soft cap or DH 169A for compatibility with goggles. Participants noted that while it was possible to wear goggles with the Soldier's Helmet, the helmets pushed down the top of the goggles causing pressure point discomfort.

Compatibility with Spectacles: Subjects wearing prescription glasses and sunglasses found that the AVH(ANR) ear cups caused pressure points behind the ears.

Clothing Compatibility: All the CVC systems were rated as "Barely to Reasonably Acceptable" for clothing compatibility. Clothing items worn by participants varied widely and included the following: Rain Coat, Combat Jacket, Armoured Vehicle Crewman's Jacket, and in a small number of cases Parka. Participants agreed that there were no significant compatibility problems with any of the CVC helmet conditions.

4.4.3.2. Ease of Head Movements

Entering/Exiting Hatches: The Shiloh-Soldiers Helmet AVH(ANR) (4.3) was rated significantly ($p < 0.05$) less acceptable than the Soft cap (5.3), Gagetown-Soldier's Helmet AVH(ANR)(5.5) and the DH 169A (5.7) for entering and exiting hatches. It should be noted that Shiloh subjects actively participated in mechanized attack drills. A number of crew commanders were forced to doff their headsets/helmets, dismount from the hatch, exit the vehicle and then had to don their new section radio Secrette headset and then don their Soldier's Helmet. Other crew commanders were required to just doff their headset as they dismounted. The headset left in the vehicle was used by other personnel to command the vehicle to the "Zulu" harbour. The Shiloh subjects felt the additional time required to remove the velcro helmet strap, remove the headset and then remove the helmet, took too long, especially during an attack when time is at a premium. The fact that Gagetown participants did not participate in attack-drills may explain why they rated the ease of entering and exiting hatches higher than the Shiloh subjects did.



Looking Through Vision Blocks: The Shiloh-Soldiers Helmet AVH(ANR) (3.7) condition was rated significantly ($p < 0.05$) less acceptable than the Soft cap (5.3), Gagetown-Soldier's Helmet AVH(ANR)(5.3) and DH 169 (5.9) for looking at vision blocks. Shiloh participants noted that the task of looking through vision blocks during the attack-dismount drills was difficult because of the standoff at the front of the helmets. Unlike the CFB Shiloh trial, participants at CFB Gagetown did not have the additional visual demand of scanning for dismounted troops and other fast moving carriers.

Looking at Gauges: The Shiloh-Soldiers Helmet AVH(ANR) (4.6) was rated significantly ($p < 0.05$) less acceptable than the Gagetown-Soldier's Helmet AVH(ANR)(5.6) and DH 169 (6.1) for looking at driver's gauges. The Soft cap was rated significantly ($p < 0.05$) less acceptable than the CVC helmet for looking at gauges. Participants noted that all helmets allowed a non-restrictive field of view and that all gauges were seen relatively easily.

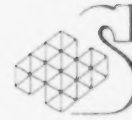
Hatches-Up Driving: All the CVC systems were rated as "Barely to Reasonably Acceptable" for driving hatches up. Participants noted that the soldiers helmets fit and stability contributed to the acceptable ratings. The CVC helmet was felt to be quite stable while driving.

4.4.3.3. Thermal Comfort

Thermal Comfort: All the CVC systems were rated as "Borderline to Barely Acceptable" for thermal comfort. While it is well known that the DH 169A is hot and uncomfortable, the weather during the CFB Gagetown trial was cool and overcast. Thus, the Gagetown thermal acceptability results may not reflect reality during temperate or hotter conditions. Based upon their extensive experience, a number of Shiloh subjects reported that the Soldier's Helmet AVH(ANR) combination was cooler than the in-service DH 169A. The stand-off in the Soldier's helmet allowed for cooling ventilation, especially while moving.

4.4.3.4. Physical Comfort

Pressure Points: The Soldiers Helmet AVH(ANR) systems were rated as "Barely to Reasonably Unacceptable" for pressure point discomfort. The Soft cap and DH 169A were rated as "Barely to Reasonably Acceptable" for pressure point discomfort. Both the Soldier's Helmet AVH(ANR) conditions(4.7) were rated significantly ($p < 0.05$) less acceptable than the Soft cap (5.6) and the DH 169A (5.5). Pressure point discomfort for the Soldier's Helmet AVH(ANR) was reported to be localized, above and behind the ears. A majority of the CFB Shiloh personnel experienced pain and headaches with the Soldier's Helmet and AVH(ANR). Discomfort was such that a number of subjects had to switch to another helmet condition prematurely. Subjects wearing prescription glasses and sunglasses found that the AVH(ANR) ear cups cause significant pressure points behind the ear. The DH 169 helmet liner has a surface covered with foam "nipples" which thus presents more generalized pressure points over the entire surface of the head.



It should be noted that the DH 169A's trialled at CFB Gagetown were brand new properly sized for the trial participants. The low time on task and proper fit may have prevented the known liner problems with the DH 169A from surfacing.

Skin Irritation: All the CVC systems were rated as "Borderline to Reasonably Acceptable" for skin irritation. Skin irritation while using the CVC helmet was attributed primarily to the surface configuration of the liner, while those reporting skin irritation with the soldier's helmet primarily identified the chin strap as the cause.

It should be noted that the DH 169A's trialled at CFB Gagetown were brand new and thus were extremely clean. The inner helmet liners of DH 169A's in-service are frequently sweat stained and covered with dirt and oil.

Weight: The Shiloh-Soldiers Helmet AVH(ANR) system was rated as "Barely to Unacceptable to Borderline" for system weight (3.4). The Gagetown-Soldiers Helmet AVH(ANR) system was rated as being "Borderline to Barely Acceptable" for system weight (4.4). The Soft cap (5.1) and the DH 169A (5.8) were rated as being "Barely to Reasonably Acceptable" for system weight. The Shiloh-Soldier's Helmet AVH(ANR) was rated significantly ($p < 0.05$) less acceptable than the Soft cap and the DH 169A for system weight. The Gagetown-Soldier's Helmet AVH(ANR) was rated significantly ($p < 0.05$) less acceptable than the DH 169A for system weight. The subjects believed that the Soldier's helmet and AVH(ANR) headset was noticeably heavier than the DH 169A.

Neck Discomfort: The Shiloh and Gagetown Soldiers Helmet AVH(ANR) systems were rated as "Barely to Unacceptable to Borderline" for neck discomfort. The Soft cap (5.4) and the DH 169a (5.8) were rated as being "Barely to Reasonably Acceptable" for neck discomfort. The Soldier's Helmet AVH(ANR) systems were rated significantly ($p < 0.05$) less acceptable than the Soft cap and the DH 169A for neck discomfort.

4.4.3.5. Driving

With the exception of driving over rough ground, the Soldiers Helmet AVH(ANR), Soft cap and DH 169A were rated as "Barely to Reasonably Acceptable" for driving tasks. The Shiloh-Soldiers Helmet AVH(ANR) system was rated as "Borderline" for driving over rough ground (4.1). The Gagetown-Soldiers Helmet AVH(ANR) system was rated as being "Barely to Reasonably Acceptable" for driving over rough ground (5.5). The Soft cap (5.6) and the DH 169A (6.0) were rated as being "Barely to Reasonably Acceptable" for driving over rough ground. The Shiloh-Soldier's Helmet AVH(ANR) was rated significantly ($p < 0.05$) less acceptable than the Gagetown-Soldiers Helmet AVH(ANR), Soft cap and the DH 169A for driving over rough ground. The fact that the Shiloh subjects participated in more realistic tactical driving involving rapid acceleration, violent turning and sudden halts may explain why their results are different from the participants of the Gagetown trial. The Gagetown trial involved tactical driving at a much-reduced tempo, i.e. lower G-forces.



4.4.4. Soldier's Helmet Versus a New Dedicated CVC Helmet

A previous investigation (Reference A) of the in-service DH 169A CVC helmet confirmed several human factors shortcomings with the helmet: inadequate fit and adjustability, physical discomfort from pressure points and contact irritation, thermal discomfort and poor ventilation, instability, incompatibility with sights and brow pads, and poor communications reliability. Participants indicated that these shortcomings contributed to poor helmet wearability and resulted in low field usage. The CF will be procuring a new CVC helmet to replace the current in-service DH 169A helmet, one that is compatible with the TCCCS family of radios and which addresses the problems with the DH 169 CVC helmet. The acceptability of using the Soldier's helmet AVH(ANR) versus a new dedicated CVC helmet was examined from a dedicated mechanized infantry perspective.

Future concept acceptability results from the exit questionnaire are displayed in Figure 10 and detailed in Table 10.

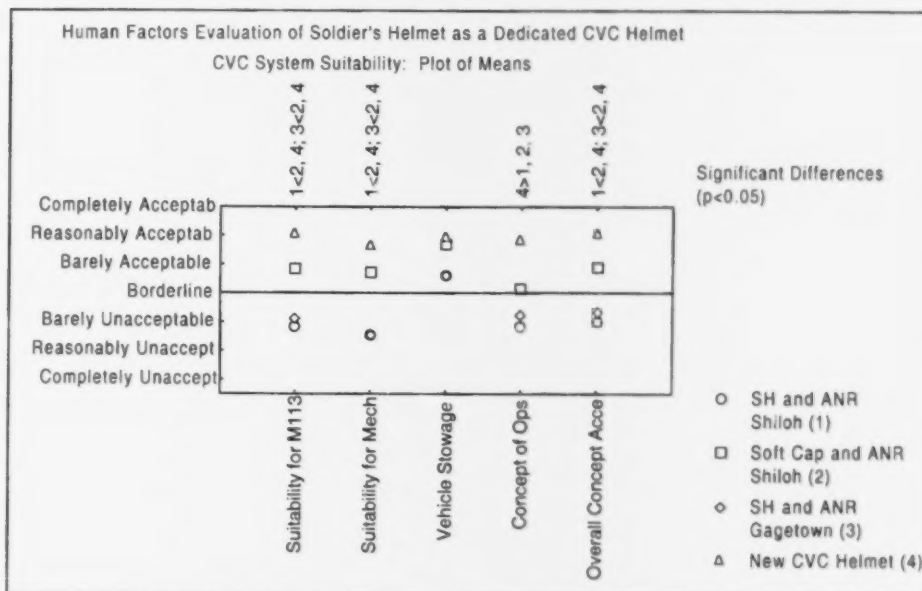


Figure 10: Exit Questionnaire Results (Soldier's Helmet and ANR Vs a New Dedicated CVC Helmet)



Features	Soldier's Helmet and ANR (Shiloh)		Soft Cap and ANR (Shiloh)		Soldier's Helmet and ANR (Gagetown)		New Dedicated CVC Helmet (Gagetown)	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Suitability for M113 Family of Vehicles	2.8	0.5	4.8	0.5	3.1	0.5	6.0	0.4
Suitability for Mechanized Infantry Tasks	2.5	0.5	4.7	0.6	2.5	0.5	5.6	0.5
Vehicle stowage	4.6	0.5	5.7	0.3	4.6	0.6	5.9	0.3
Concept of Ops (One Vs Two Helmet System)	2.8	0.7	4.1	0.7	3.2	0.6	5.8	0.4
Overall Concept Rating	3.0	0.5	4.9	0.5	3.3	0.4	6.0	0.3

Table 10: Exit Questionnaire Results (Combined Helmet and Communications)

4.4.4.1. Features

Suitability for M113 family of Vehicles: The Soldiers Helmet AVH(ANR) systems were rated as "Barely to Reasonably Unacceptable" for suitability for use with the M113 family of vehicles. The Soft cap (4.8) and future dedicated CVC helmet (6.0) were rated as "Barely to Reasonably Acceptable" for use with the M113 family of vehicles. The Soldier's Helmet AVH(ANR) conditions(2.8 and 3.1) were rated significantly ($p < 0.05$) less acceptable than the Soft cap or a future dedicated CVC helmet.

Suitability for Mechanized Operations: The Soldiers Helmet AVH(ANR) systems (2.5) were rated as "Barely to Reasonably Unacceptable" for suitability for use in mechanized infantry operations. The Soft cap (4.7) and future dedicated CVC helmet (5.6) were rated as "Barely to Reasonably Acceptable" for in mechanized infantry operations. The Soldier's Helmet AVH(ANR) conditions(2.5) were rated significantly ($p < 0.05$) less acceptable than the Soft cap or a future dedicated CVC helmet.

Vehicle Stowage: All the CVC system concepts were rated as "Borderline to Reasonably Acceptable" for vehicle stowage. Subjects did not believe that carrying and stowing two helmets posed any significant stowage problem. Subject were concerned about the durability and stowage of the AVH(ANR) headsets.



While a dedicated CVC helmet would protect the communication headsets somewhat, removable headsets may be more fragile.

Concept of Operations (one vs. two helmets): The single helmet concept of operations (represented by the soldiers helmet and the soft cap) was rated significantly lower ($p < 0.05$) than the two helmet concept (dedicated CVC helmet and Soldiers Helmet for dismounted operations). Participants cited increased communication headset durability, user comfort, and faster transitions to dismounted operations as the primary determinants for their preference. Although the doctrine of using the new TCCCS squad level radio has not been finalized, the section and platoon commanders (vehicle crew commanders) during the Shiloh trial were required to carry the TCCCS VSSR radio and wear the Secrette headset after dismounting from their vehicle. To don the Secrette headset, users are required to doff their helmets completely and thus any added benefit of an independent and removable communication system is lost. All the subjects believed that the AVH(ANR) headset is too bulky and restrictive to wear while doing dismounted attacks. Additionally, removing the headset from the vehicle will cause additional problems for crew commanding the "Zulu" vehicles.



5. Discussion

As mentioned earlier, the CF will be procuring a new CVC helmet to replace the deficient in-service DH 169A CVC helmet. This new helmet or series of helmets will overcome the limitations and deficiencies of the DH 169A, most notably communications reliability, physical and thermal comfort, equipment and vehicle compatibility and compatibility with the TCCCS family of vehicle mounted radios.

In the first stage of this investigation a review of user needs was conducted. Human factors performance criteria and test protocols for a new dedicated CVC helmet were developed based on insights derived from: user feedback on the current in-service DH 169A CVC helmet, an assessment of user needs across a range of CF armoured vehicles and crew stations, a user evaluation of commercial-off-the-shelf (COTS) CVC helmets and a review of the scientific literature on CVC helmets.

The investigation of the in-service DH 169A CVC helmet confirmed several human factors shortcomings: inadequate fit and adjustability, physical discomfort from pressure points and contact irritation, thermal discomfort and poor ventilation, instability, incompatibility with sights and brow pads, and poor communications reliability. Participants indicated that these shortcomings contributed to poor helmet wearability and resulted in low field usage. Based on a review of the COTS CVC helmets at CFB Gagetown, with one or two crews in a variety of CF armoured vehicles, it appeared unlikely that one CVC helmet design could accommodate the entire range of vehicle characteristics and crewstation requirements in the CF. This investigation suggested the need to investigate two helmet designs (i.e. a dedicated CVC helmet and an infantry capable helmet each with different requirements, according to their concept of operations and individual crewstation demands. The need for a dedicated CVC helmet was recognized for the following armoured vehicles: the Leopard family of vehicles, Cougar, TOW under armour (TUA), and the M109. Conversely the analysis of operational, vehicle and crewstation demands recognized the potential need for an infantry capable helmet for: AVGPs, Bison's, Coyote's, future infantry section carriers (Kodiak's) and the M113 family of vehicles (less TUA).

The suitability of using the new Soldier's Helmet and detachable communication headsets was subsequently investigated to determine if this hybrid system could meet the CVC requirements for the wheeled family of vehicles (less Cougar) and the tracked M113 family of vehicle (less TUA). The first phase of this investigation was to determine the physical comfort and fatigue effects of wearing a relatively heavy infantry helmet with the detachable TCCCS communication headset with wheeled vehicles. Since TCCCS Vehicle headsets (VH) and Armoured Vehicle Headsets - AVH(ANR) were not available, Slimgard II headsets were evaluated with the Soldier's Helmet. This hybrid CVC system was tested on two driver wheeled courses at CFB Petawawa in uncontrolled user evaluations. The results of these AVGP wheeled vehicle trials indicated that the Soldier's helmet and Slimgard II CVC helmet system was acceptable for AVGP vehicles. This hybrid system was found to be superior to the significantly deficient DH 169A.

While it was determined that the Soldier's helmet and Slimgard II headset was acceptable for use in the wheeled family of vehicles (less Cougar), the acceptability of using the Soldier's Helmet and the heavier and bulkier AVH(ANR) headset in tracked vehicles was unknown. The aim of this



study was to evaluate the Soldier's Helmet and AVH(ANR) headset as a dedicated CVC helmet with the M113 tracked vehicles (less TUA) and to specifically address the following issues.

- Determine the compatibility of the TCCCS AVH(ANR) headset when used with the Soldier's Helmet.
- Determine the performance and acceptability of the TCCCS AVH(ANR) and the Soldier's Helmet as a dedicated CVC helmet system.
- Based on the results of this trial propose changes to the human factors-related functional performance specifications.

5.1. Compatibility of the TCCCS AVH(ANR) Headset and Soldier's Helmet

Compatibility between the TCCCS AVH(ANR) headset and the Soldier's Helmet were evaluated in a number of areas: physical compatibility with clothing and equipment, physical comfort and user task compatibility. Over all the participants found the Soldier's helmet and AVH(ANR) more difficult to use than the comparable Soft cap or DH 169A. Participants rated the ease of use as a system as being significantly less acceptable than the Soft cap or DH 169A.

The results of the M113 tracked vehicle trial will be discussed both in terms of the specific findings of this investigation and will be contrasted to the earlier Soldier's helmet and Slimgard II wheeled vehicle trial results where warranted.

5.1.1. Physical Compatibility

Participants generally rated the physical compatibility acceptability of the soldier's helmet and the AVH(ANR) communications headset as being "Barely Unacceptable to Barely Acceptable". With the exception of "clothing compatibility", which were not rated significantly different, all other measures of physical compatibility for the Soldier's helmet AVH(ANR) were rated significantly less acceptable than the soft cap or DH 169 in-service CVC helmet. A major problem area identified in the trial were the number of different helmet and communication headset harness straps, tensioning bands and retention straps as well as goggle straps competing for the same space.

A problem for a number of subjects was the apparent clash between the Soldier's helmet and the AVH(ANR) headset ear cups. While it is possible to don the helmet over the ear cups (or slide the headset ear cups underneath the helmet ear cups) prolong use results in pressure point discomfort.

The results of the M113 tracked trials are different than the earlier wheeled AVGP compatibility results. The Soldier's Helmet and Slimgard II CVC system was rated as being "Barely to Reasonably Acceptable" for equipment compatibility. Although the head over Velcro straps were also prone to slippage in the wheeled trial, participants did not believe that the strap slippage adversely affected their ear seal or comfort. The wheeled vehicle trial participants believed that the strap issue could become a source of annoyance. It should be noted that the AVGP results were based on driving over prepared roads and trails and that participants had ample time to properly adjust their helmets and straps. Additionally the driving conditions at CFB Petawawa were less demanding than CFB Shiloh or CFB Gagetown.



5.1.2. Physical Comfort and Fatigue Effects

Acceptability ratings for the physical comfort of the soldier's helmet, when combined with the weight of the AVH(ANR) communications headset indicate that the participants generally found the configuration as "Barely to Reasonably Unacceptable". With the exception of "skin irritation and hot spots", which were not rated significantly different, all other measures of physical comfort for the Soldier's helmet AVH(ANR) were rated significantly less acceptable than the soft cap or DH 169A in-service CVC helmet. The negative effects of the increased weight of the Soldiers helmet AVH(ANR) configuration (neck discomfort, fatigue onset and duration) were not mitigated by the superior stability, fit and low standoff of the soldiers helmet. Pressure point discomfort associated with the Soldier's helmet and AVH(ANR) was significant; fourteen of sixteen Shiloh participants noted pain and discomfort with the Soldier's Helmet and AVH(ANR).

The neck discomfort acceptability results of the M113 tracked trials appear to be different than the earlier wheeled AVGP results. See figure 11. The differences in the ride dynamics between the tracked and wheeled vehicles may account for some of the recorded differences. Tracked vehicles were and are subject to more violent accelerations, turns and decelerations than comparable wheeled vehicles. As well, the superior suspension systems on wheeled vehicles tend to dampen vibrations resulting in more harmonic rather than random vibrations. These higher tracked vehicle random accelerations combined with the higher weight of the Soldier's helmet and AVH(ANR) may explain the greater reported instances of neck discomfort.

The comfort results of the M113 tracked trials may also be different than the earlier wheeled AVGP results because of the trial conditions. The AVGP results were based on driving over prepared roads and trails. There was limited driving over rough ground during the driving instruction course. Conversely the tracked driving results were based primarily on driving over rough ground while participating in mechanized infantry operations.

The pressure point acceptability results of the M113 tracked trials are different than the earlier wheeled AVGP results. See figure 12. The shape of the Slimgard II communication headset used during the wheeled AVGP trials were significantly different than the TCCCS AVH(ANR) headset used in the tracked M113 trials. The Slimgard II ear cups have a reduced upper ear profile than the TCCCS AVH(ANR) ear cups. While many subjects reported pressure point discomfort at the top of the ears with the TCCCS AVH(ANR) headset, the wheeled trial participants did not report a similar problem with the Slimgard II. It appears that there was clash between the Soldier's helmet and TCCCS AVH(ANR) headset.

The results of the M113 tracked trials may also be different than the earlier wheeled AVGP results because of the differences between actual time on task. The earlier wheeled driving trials relied on self-reported hours of wear and actual use was not monitored by a HF observer. Conversely, the hours of wear of the Soldier's helmet and the AVH(ANR) in the tracked trials was controlled and monitored by HF observers. The participants in the wheeled AVGP trials specifically noted that the duration of helmet usage during the driving courses might have been insufficient to completely address physical comfort issues.



Neck Discomfort		Rating Scale									
Fighting Order	Mean	S.E.	Wholly Unacceptable			Borderline			Wholly Acceptable		
			⊗ 1	2	3	4	5	6	7		
ANR Shiloh	3.8	0.5									
Soft cap (Shil)	5.4	0.4									
ANR Gagtown	3.9	0.7									
CVC (Gage)	5.8	0.4									
Slim II (Peta)	5.4	0.3									
DH 169 (Peta)	5.2	0.2									

Figure 11: Neck Discomfort Acceptability Ratings (Tracked and Wheeled Trials)

Pressure Point Acceptability		Rating Scale									
Helmet Condition	Mean	S.D.	Wholly Unacceptable			Borderline			Wholly Acceptable		
			⊗ 1	2	3	4	5	6	7		
ANR Shiloh	2.6	0.5									
Soft cap (Shil)	5.3	0.4									
ANR Gagtown	2.8	0.4									
CVC (Gage)	5.3	0.5									
Slim II (Peta)	4.6	0.5									
DH 169 (Peta)	4.4	0.4									

SHS = ANR Shiloh, SC = Soft cap Shiloh, AG = ANR Gagtown, CVC = DH 169 Gagtown, Slim = Slingard II Peta, DH169 = DH 169 Peta

Figure 12: Pressure Point Discomfort Acceptability Ratings (Tracked and Wheeled Trials)



5.1.3. Task Compatibility

Participants generally rated the task compatibility acceptability of the Soldier's Helmet and the AVH(ANR) communications headset as being "Barely Unacceptable to Reasonably Acceptable". The Soldier's Helmet and AVH(ANR) was generally rated significantly less acceptable than the Soft cap and DH 169 for driving tasks and driving over rough ground. A major problem area identified in the trial were the number of different helmet and communication headset harness straps, tensioning bands and retention straps as well as goggle straps competing for the same space.

The task acceptability results of the M113 tracked trials appear to be different than the earlier wheeled AVGP results, where the Soldier's Helmet and Slimgard II headset was rated as being "Barely to Reasonably Acceptable". The differences in the ride dynamics between the tracked and wheeled vehicles and crew stations may account for some of the recorded differences.

5.2. Performance and Acceptability of the TCCCS AVH(ANR) Headset and the Soldier's Helmet as a Dedicated CVC Helmet

While the Soldier's Helmet/Slimgard II configuration was rated as "largely acceptable" for use as a CVC helmet in the earlier wheeled combat vehicle trial, the Soldiers Helmet AVH(ANR) systems were rated as "Barely to Reasonably Unacceptable" for suitability for use with the M113 family of vehicles. One concern of the users was the poor fit of the communications headset AVH(ANR) after prolonged wear. Users complained that the heavy headsets and helmet slipped when the helmet comfort band was sweaty allowing the headset to slip down there by putting pressure on top of the ears. The velcro helmet retention strap frequently slipped off the helmet and thus did not support the headset as envisioned.

Unlike the Soldier's Helmet/Slimgard II configuration which was rated as "largely acceptable" for ease of use as a system and concept of operations (one vs. two helmets), the Soldiers Helmet AVH(ANR) systems were rated as "Barely to Reasonably Unacceptable" for these criteria. Subjects rated that the Soldier's Helmet and AVH(ANR) as an unacceptably complicated system. More significantly subjects rated the Soldiers Helmet AVH(ANR) systems as being "Barely to Reasonably Unacceptable for mechanized infantry operations. As identified in the earlier trial, an important determinant for the soldiers helmet suitability to task was the proposed concept of operations. Utilizing the soldier's helmet as both a CVC helmet while inside the vehicle and an infantry helmet while performing dismounted operations was considered in the Wheeled AVGP trial to have many positive outcomes. These were reflected in reduced storage requirements, faster transitions to dismounted operations, increased ballistic protection and personal vs. vehicle issue for helmets. The participants in the earlier trial were primarily drivers and did not practice mechanized infantry operations, nor did they practice crew combat dismount drills. The Soldier's Helmet and AVH(ANR) participants cited faster transitions to dismounted operations as the primary determinants for their preference for a dedicated CVC helmet. The need to don the Secrete headset for dismounted operations required crew commanders to completely doff their helmets and thus any added benefit of an independent and removable communication system was lost. All the subjects believed that the AVH(ANR) headset was too bulky and restrictive to wear while doing dismounted attacks.



Another concern of the Soldier's Helmet and AVH(ANR) participants was the durability of the independent TCCCS AVH(ANR) headsets. Loose headsets are subject to tremendous abuse inside infantry carriers and it is questionable that the sophisticated and delicate TCCCS AVH(ANR) headset can withstand the operating and storage environment. During the very limited and controlled tracked M113 field trials three of the 10 systems available were damaged. Cables easily pulled out of the ear cups and microphones while earphones went dead. Some of the difficulties may be due to the modifications to the 2298 boxes required to conduct the trial. It should be noted however that the 2298 boxes were reconfigured according to TCCCS power and signal specifications. Another area of concern for the Soldier's Helmet and AVH(ANR) participants was the velcro helmet strap. While the strap may work as envisioned new, users were concerned that the straps wouldn't hold when dirty, wet or frozen with snow and ice. The straps themselves frequently slip off the helmet providing no support to the heavy headsets.

Overall, the Soldier's Helmet and AVH(ANR) participants preferred the fielding of a new dedicated CVC helmet for M113 tracked vehicles. Although these results may appear different than the earlier Soldier's Helmet and Slimgard II trial recommendations, they are for different headsets and vehicles. As discussed earlier, the original need for different CVC designs was based upon concept of operation and crew station demands. It was envisioned in the earlier CVC helmet trials that mechanized infantry crew commanders would just have to remove their headsets during their dismount drills and thus not have to bother with donning their infantry helmet. The subsequent fielding of the section level VSSR radio has challenged this assumption. During the CFB Shiloh trials section and platoon commanders wore the TCCCS Secrette headsets when dismounted. These commanders had to completely doff their soldier's helmets to properly don the Secrette ear-piece. Even though the AVH(ANR) headset has acoustic valves, the participants did not believe wearing the AVH(ANR) headset was feasible during dismounted operations. The AVH(ANR) headset was too big and bulky to wear on foot and the act of removing it from the vehicle jeopardizes moving the "Zulu" vehicles on the battlefield.



6. Recommendations

While the Soldier's Helmet and AVH(ANR) headset combination was superior to the significantly deficient in-service DH 169, it was not the preferred solution for providing CVC helmet systems to M113 tracked vehicles. When asked outright which concept they would select, 25 out of the 26 trial subjects (96%) chose a new dedicated CVC over the hybrid Soldier's Helmet and AVH(ANR) system. The subjects envisioned a new CVC helmet that would overcome the limitations of the DH 169 and would be compatible with the new TCCCS vehicle mounted radio systems. Areas for improvement include:

- Physical comfort
- Thermal comfort
- Communications reliability
- Ballistic protection
- Fit
- Weight
- User maintainability
- Equipment and vehicle compatibility

Having selected a dedicated CVC helmet as the most suitable concept for further fielding with the M113 family of vehicles, the optimum dedicated CVC design must now be identified. There are a number of program approaches that could be pursued, each with its own risk. These approaches include:

- Conduct a survey and test COTS CVC systems to identify a COTS solution if possible. Testing to include human factors performance criteria.
- Team with industry to develop a suitable CVC design.

6.1. Proposed Changes to the Human Factors –Related Functional Performance Specifications

The following are proposed changes to the original draft HF Performance Criteria for a new CVC helmet.

6.1.1. Aural Characteristics

No changes proposed.



6.1.2. Accessibility

Include the Clothe the Soldier (CTS) Cold Wet Weather Glove (CWWG) in the accessibility requirement. Accessibility to be evaluated by speed of donning and doffing and by a rating of ease of accessibility.

6.1.3. Adjustability

No changes proposed.

6.1.4. Camouflage

No changes proposed.

6.1.5. Communications

The communication requirements should be based upon the relevant TCCCS radio system and accessories specifications.

6.1.6. Compatibility

Include the Clothe the Soldier (CTS) Cold Wet Weather Glove (CWWG) in the clothing compatibility tests. Include the driver's viewing aide (DVA), and the M113 infantry section carrier, Coyote (LAV Recce), Kodiak and APC-LE (life extension) vehicles in the weapon sight and crew station compatibility test stands.

6.1.7. Field of View

Modify the requirement to read "The helmet shall not significantly reduce a soldier's peripheral field of view" in the vertical or horizontal plane.

6.1.8. Fit

The sizing should be based upon the DCIEM 1997 Anthropometric Survey.

6.1.9. Functionality

Include mechanized infantry tasks. Crew commanders will be required to debus from their vehicles and participate in dismounted infantry attacks. Crew commanders will be required to don Secrete headsets after debussing.

6.1.10. Physical Comfort

Include neck discomfort – The helmet shall minimize any neck discomfort. Soldier's will be required to rate their physical comfort following mechanized infantry training on M113 tracked vehicles. Training to be in a combat team advance to contact/attack/obstacle breaching context.

6.1.11. Protection

No changes proposed.



6.1.12. Range of Motion

No changes proposed.

6.1.13. Stability

Include neck strain in physical comfort criteria.

6.1.14. Thermal Load

No changes proposed.

6.1.15. User Maintainability

No changes proposed.

6.1.16. User Acceptance

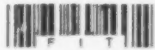
No changes proposed.

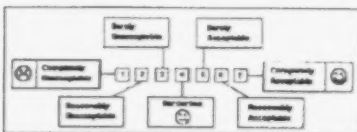
6.1.17. Weight

No changes proposed.



Annex A: Fit Questionnaire



PERSONAL DATA Clearly print your Name and Helmet Type in the boxes provided.

NAME HELMET

Rate the following Features	User Acceptance Rating							Subject Comments
	⊗ 1	2	3	4	5	6	⊗ 7	
Ease of Assembly	☐	☐	☐	☐	☐	☐	☐	
Shell Attachment	☐	☐	☐	☐	☐	☐	☐	
Chin strap adjustment	☐	☐	☐	☐	☐	☐	☐	
Harness adjustment	☐	☐	☐	☐	☐	☐	☐	
Final fit	☐	☐	☐	☐	☐	☐	☐	
Ease of Donning	☐	☐	☐	☐	☐	☐	☐	
Ease of Doffing	☐	☐	☐	☐	☐	☐	☐	
First impressions?								
Appearance	☐	☐	☐	☐	☐	☐	☐	
Durability	☐	☐	☐	☐	☐	☐	☐	
Protection	☐	☐	☐	☐	☐	☐	☐	

Observer Comments:

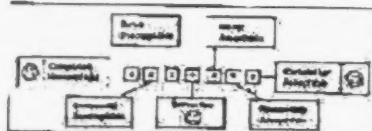


Annex B: Exit Questionnaire





Software Right/Upgrade



PERSONAL DATA

NAME: 0000-0000000000

Please indicate, in the boxes provided, the estimated number of hours spent wearing each helmet:

Soldiers Helmet and AVH(ANE) 00 DH-105 CVG Helmet 0000

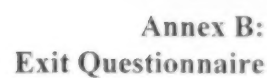
HELMET TYPE	SOLDIERS HELMET AND AVH(ANE)	DH-105 CVG HELMET
	1 2 3 4 5 6 7	1 2 3 4 5 6 7
Initial Fit	0 0 0 0 0 0 0	0 0 0 0 0 0 0
Fit After Wear	0 0 0 0 0 0 0	0 0 0 0 0 0 0
Donning/Doffing in Vehicle	0 0 0 0 0 0 0	0 0 0 0 0 0 0
Knee Pad Adjustment in Vehicle	0 0 0 0 0 0 0	0 0 0 0 0 0 0
Knockout	0 0 0 0 0 0 0	0 0 0 0 0 0 0
Bump Protection	0 0 0 0 0 0 0	0 0 0 0 0 0 0
Ballistic Protection	0 0 0 0 0 0 0	0 0 0 0 0 0 0
Drivability	0 0 0 0 0 0 0	0 0 0 0 0 0 0
Visions	0 0 0 0 0 0 0	0 0 0 0 0 0 0
OVERALL RATING HELMET	0 0 0 0 0 0 0	0 0 0 0 0 0 0



Annex B: Exit Questionnaire



Item	1	2	3	4	5	6	7	8	9	10
Fit/Comfort Wear	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Dressing/Doffing with Helmet	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Ease of Adjustment in Vehicle	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Strapping	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Entanglement With Drop Cord	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Communication Performance										
Ear Seal	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Speech Quality	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Wind Noise	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Howling Quality (ANE)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Hearing Quality (Talk Through)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Sound Localization	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Microphone Positioning	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
RT Switch	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Head-over Vehicle Straps	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Noise Protection	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Ease of Adjustment to Minimize Quasars Distortion and Signal Loss	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
OVERALL RATING COMMENTS	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐



Humansystems Incorporated



Annex B: Exit Questionnaire



HUMAN SYSTEMS INCORPORATED		
Description of System/Component	Suitability for Home/Office Use	Suitability for Industrial/Commercial Use
Driving		
Hard Surface	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
Gravel Surface	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
Rough Ground	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
Right Driving	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
Feeding	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
Suitability for M113 Family of Vehicle	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
Suitability for Mainline Industrial Trucks	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
Vehicle Storage	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
Concept of Ops (i.e., One vs. Two Helms/Sections)	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
OVERALL SYSTEM RATING	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

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